64th Annual Meeting
of the International Society of Electrochemistry

INSTITUTO DE INVESTIGACIONES FISICOQUÍMICAS TEÓRICAS Y APLICADAS

Centro de Investigación y Desarrollo en Ciencia y Tecnología de Materiales

Electrochemical Characterization of Nickel Hydroxide Electrodes with MWCNT

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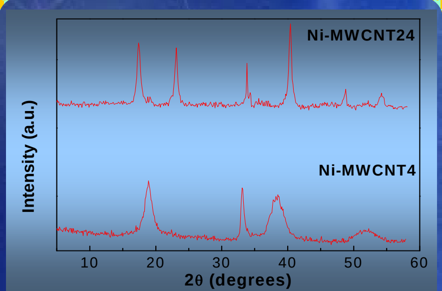
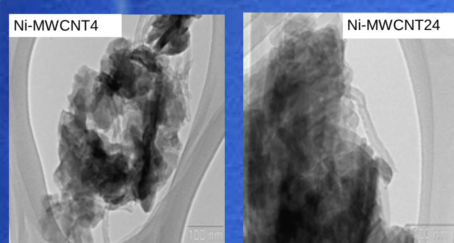
INTRODUCCION

Alkaline secondary batteries are widely required in the current market of electronic devices. Particularly, nickel hydroxide active material is the positive electrode in Ni/H_2 and Ni/MH batteries. Due to their semiconductor nature, it becomes necessary to solve this limitation. A poor electrical contact yields ohmic overpotential and capacity loss at high currents. The carbon nanotubes (CNT) employed as additive was first studied by *Lv et al*. [1] who found that the addition of NTC may improve battery performance at high download speeds. However, discussions about the way that CNT affect structural and kinetic parameters are still lacking.

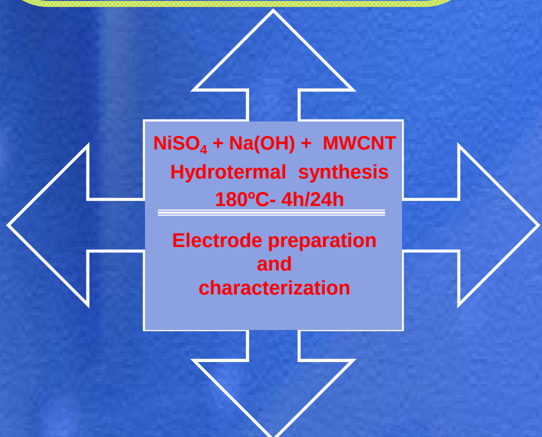
In this work, the addition of multiwall carbon nanotubes (MWCNT) is investigated. The active material was prepared by hydrothermal synthesis method. The characterization was performed by optical (SEM, TEM, XRD) and electrochemical techniques (charge-discharge cycles, cyclic voltammetry, electrochemical impedance spectroscopy-EIS-). The EIS technique along with a physicochemical model developed in the laboratory, are powerful tools for the estimation of physicochemical and structural parameter such as: specific active area, effective conductivity and diffusion coefficient of H^+ [2]. This knowledge allows electrochemical performance optimization of the systems.



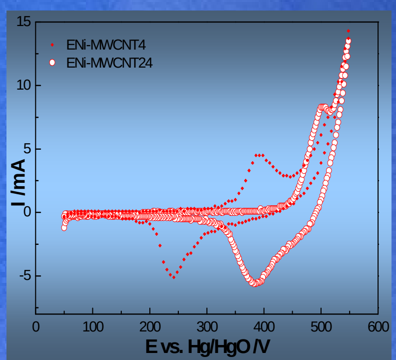
XRD patterns of synthesized material

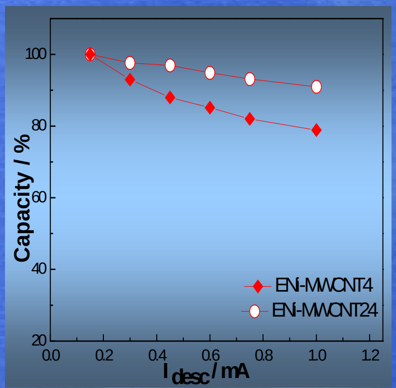


TEM images of synthesized material



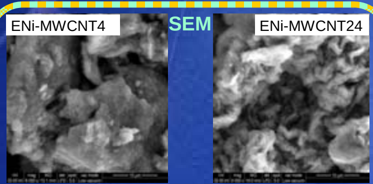
Cyclic Voltammetry



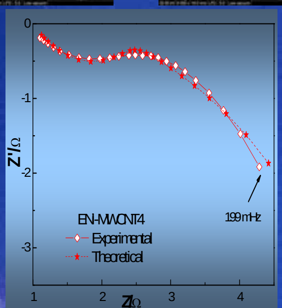


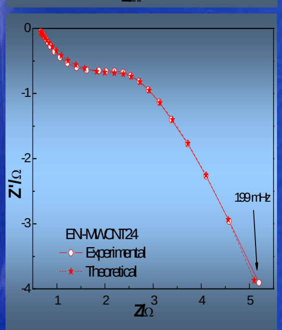
Rate Capability

SEM



EIS





The transfer function of a porous structure, Zp, can be written as:

$$Z_P = \frac{L}{A_g k}\left(\frac{1}{\nu \tanh \nu}\right)$$

Being: $\nu = L\left(\frac{1}{k}\right)^{1/2} Z_i^{-1/2}$

$Z_i^{-1} = Z_{dc}^{-1} + Z_F^{-1}$ $\quad Z_F = \frac{Z_f}{a_a} \quad Z_{dc} = \frac{1}{j\omega C_{dc} a_e}$

Electrode	*SOD*	*C_i[Fcm^{-3}]*	*κ[$Ω^{-1}cm^{-1}$]*	*σ[$Ω^{-1}cm^{-1}$]*	*D [cm^2s^{-1}]*
ENi-MWCNT4	75	0.09	0.06	29	1.5 $x10^{-13}$
ENi-MWCNT24		0.12		18	2.8 $x10^{-13}$

CONCLUSIONS

- Active materials for cathodes were prepared by hydrothermal route. These were made by mixing β-Ni $(OH)_2$ with MWCNT as additive.
- Compounds obtained with 24 h of synthesis present higher discharge capacity and improved reversibility of the peaks associated with $Ni(OH)_2$/NiOOH pair.
- The estimated effective conductivity values of solid phase were found to be high in both electrodes.
- The better electrochemical behavior of ENiMWCNT24 sample it is considered to be related to their increased active area values.

[1] Lv J, Tu J P, Zhang W K, Wu J B, Wu H M, Zhang B. J. Power Sources, 132 (2004), 282-287.
[2] Ortiz M. , Becker D. , Garaventta G. , Visintin A. , Castro E. B . and Real S. G. . Electrochimica Acta 56 (2011), 7946–7954.